CLAIMS

1. A DC converter that alternately turns on and off a main switch being connected in series with a primary winding of a transformer and a sub-switch being connected in series with a capacitance, the series circuit of the sub-switch and the capacitance being connected to each end of the primary winding of the transformer or to each end of the main switch, and the DC converter rectifies and smoothes a voltage of a secondary winding of the transformer with a rectifying/smoothing circuit, and provides a DC output, the DC converter comprising:

a time difference detector to detect an interval between when the main switch reaches a minimum voltage after the sub-switch is turned off and when the main switch is turned on; and

a delay controller to delay the ON timing of the main switch according to an output from the time difference detector so that the main switch is turned on at around the minimum voltage.

2. A DC converter that alternately turns on and off a main switch being connected in series with a primary winding of a transformer and a sub-switch being connected in series with a capacitance, the series circuit of a capacitance and the sub-switch being connected to each end of the primary winding of the transformer or to each end of the main switch, and the DC converter rectifies and smoothes a voltage of a secondary winding of the transformer with a rectifying/smoothing circuit, and provides a DC output, the DC

converter comprising:

a bottom detector to detect a minimum voltage of the main switch when the main switch decreases voltage after the sub-switch is turned off;

an ON detector to detect an instance when the main switch is turned on;

a time difference detector to detect an interval between when the bottom detector detects the minimum voltage and when the ON detector detects an ON state of the main switch; and

a delay controller to delay the ON timing of the main switch according to an output from the time difference detector so that the main switch is turned on at around the minimum voltage.

3. The DC converter of claim 1, further comprising:

an integrator to integrate the output from the time difference detector,

the delay controller delaying the ON timing of the main switch according to an integrated output from the integrator so that the main switch is turned on at around the minimum voltage.

4. The DC converter of claim 2, further comprising:

an integrator to integrate the output from the time difference detector,

the delay controller delaying the ON timing of the main switch according to an integrated output from the integrator so that the main switch is turned on at around the minimum voltage.

5. The DC converter of claims 1, further comprising:

an adder to add up the output from the time difference detector; and

a subtracter to subtract a predetermined value from a sum from the adder at every ON/OFF period of the main switch,

the delay controller delaying the ON timing of the main switch according to an output from the adder so that the main switch is turned on at around the minimum voltage.

6. The DC converter of claim 2, further comprising:

an adder to add up the output from the time difference detector; and

a subtracter to subtract a predetermined value from a sum from the adder at every ON/OFF period of the main switch,

the delay controller delaying the ON timing of the main switch according to an output from the adder so that the main switch is turned on at around the minimum voltage.

7. The DC converter of claim 3, wherein the delay controller has:

a delay part to delay a signal to turn on the main switch by a predetermined delay time according to a charging time of a delay capacitor connected in series with a resistor; and

a variable delay part to provide the delay capacitor with a voltage difference between the integrated output from the integrator and a reference voltage, thereby shortening the predetermined delay time according to the voltage difference,

a control signal generated according to a voltage of the delay capacitor being applied to a control terminal of the

main switch.

8. The DC converter of claim 4, wherein the delay controller has:

a delay part to delay a signal to turn on the main switch by a predetermined delay time according to a charging time of a delay capacitor connected in series with a resistor; and

a variable delay part to provide the delay capacitor with a voltage difference between the integrated output from the integrator and a reference voltage, thereby shortening the predetermined delay time according to the voltage difference,

a control signal generated according to a voltage of the delay capacitor being applied to a control terminal of the main switch.

9. The DC converter of claim 5, wherein the delay controller has:

a delay part to delay a signal to turn on the main switch by a predetermined delay time according to a charging time of a delay capacitor connected in series with a resistor; and

a variable delay part to provide the delay capacitor with a voltage difference between the output from the adder and a reference voltage, thereby shortening the predetermined delay time according to the voltage difference,

a control signal generated according to a voltage of the delay capacitor being applied to a control terminal of the main switch.

10. The DC converter of claim 6, wherein the delay controller has:

a delay part to delay a signal to turn on the main switch by a predetermined delay time according to a charging time of a delay capacitor connected in series with a resistor; and

a variable delay part to provide the delay capacitor with a voltage difference between the output from the adder and a reference voltage, thereby shortening the predetermined delay time according to the voltage difference,

a control signal generated according to a voltage of the delay capacitor being applied to a control terminal of the main switch.

11. The DC converter of claim 1, further comprising:

a voltage rectifying part to rectify a DC power source or an AC voltage of an AC power source and provide a rectified voltage, the voltage rectifying part being connected to each end of a series circuit including the primary winding of the transformer and the main switch.

12. The DC converter of claim 2, further comprising:

a voltage rectifying part to rectify a DC power source or an AC voltage of an AC power source and provide a rectified voltage, the voltage rectifying part being connected to each end of a series circuit including the primary winding of the transformer and the main switch.

13. The DC converter of claim 1, further comprising:

a reactor connected between the primary winding of the

transformer and the main switch; and

a sub-transformer being connected in series with the transformer, to reflux energy accumulated when the main switch is ON in the reactor to a secondary side when the main switch is turned off.

14. The DC converter of claim 2, further comprising:

a reactor connected between the primary winding of the transformer and the main switch; and

a sub-transformer being connected in series with the transformer, to reflux energy accumulated when the main switch is ON in the reactor to a secondary side when the main switch is turned off.

15. The DC converter of claim 13, wherein:

the reactor is a leakage inductance between the primary and secondary windings of the transformer that are loosely coupled around a core of the transformer; and

the primary winding of the transformer and a secondary winding of the sub-transformer are closely coupled around the core of the transformer.

16. The DC converter of claim 14, wherein:

the reactor is a leakage inductance between the primary and secondary windings of the transformer that are loosely coupled around a core of the transformer; and

the primary winding of the transformer and a secondary winding of the sub-transformer are closely coupled around the core of the transformer.